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Laboratory Appliances.

BY JOHN M. COULTER.

The matter presented in this paper is chiefly an editing of information received from some of our principal botanical laboratories, either by correspondence or by personal inspection. As is well known, most of our laboratories are equipped not so much for the use of trained investigators, but to train investigators; hence the teaching aspect is the most prominent, and the most useful notes to our laboratory workers are those which concern methods of teaching. Our teachers are abundantly able to take care of their own original investigations, but in teaching others how to work they are always more than ready to receive hints. This and the other papers of this number, therefore, are not intended to apply to the professional laboratory, but to the teaching laboratory. The writer then intends to act as a middleman for his fellow teachers and interchange for them their ideas upon the subject of appliances.

An almost unanimous expression is that all appliances should be of the simplest kind, as the best of our work has been done by simple appliances, and such are also much cheaper. The attractive catalogues of our instrument makers should be read with care, for they contain many things of very little use in our work and many other things that can be devised at home and answer the purpose just as well. But the notion of simplicity and cheapness must not be carried too far, as, for instance, it is worse than useless to put in the hands of even beginners cheap and hence poor lenses. To classify the subject, we will treat it under the heads suggested by Prof. Bessey.

MICROSCOPES.—*Compound.* Simple low stands seem to be almost universally used, but it is absolutely necessary that they be able to carry any objective. This advice would seem unnecessary, but the writer has in mind more than one laboratory loaded down with stands so cheap that they are really useless for fine work. Foreign stands and those manufactured in our own country are in about equal demand, and it would be hard to convince the users of either that they could better themselves by using the other, all of which shows that good work can be done with both, and a great deal depends upon what one is accustomed to. In some laboratories the stands are so low ("continental" pattern) that the stage may be kept horizontal for all work, which has its advantages. In all cases the microscope is provided with two objectives, in some cases with one eye-piece, but mostly with two. In the matter of objectives there is a range from 1 inch to $\frac{1}{6}$, the two most commonly used being 1 inch and $\frac{1}{4}$. Such pairs as $\frac{1}{2}$ and $\frac{1}{6}$, $\frac{2}{3}$ and $\frac{1}{5}$ are also in common use. The high power should be of as long working distance as possible. Of course all the laboratories have higher powers that can be used as occasion demands. Several have well emphasized the great advantage of providing thoroughly good objectives even for elementary work, for nothing can be more discouraging or confusing to a beginner than to be asked to try to see with an objective so poor that even his instructor could not use it. Professor Spalding urges the use of a double nose-piece as a great means of saving time as well as wear and tear. In some laboratories eye-piece micrometers are used, and in the University of Nebraska these are simple discs of thin glass upon which a small scale is ruled, and the disc fastened into the tube of the B eye-piece. Such micrometers, when ordered with the instrument, cost about $1.50 each. More laboratories appear to provide stage micrometers, and in some cases one micrometer is made to serve the needs of all the students by each one making measuring slips of his own. This is very simply done by tracing on slips of card-board the micrometer lines by means of the camera with every power used. In this way every camera drawing can be measured directly. In the matter of camera drawing the practice varies considerably. Some require it always; others, in addition to its constant use, require larger free-hand drawings as better illustrating the minor details; others require its use only when exact outlines are needed, or when measurements are to be made; others teach its use and then leave it optional with the student, one saying that "the best workers soon come to prefer the camera;" still others never use it, but only require free-hand drawing. In this wide range of habit the teacher is left to consult his own judgment, except that it would at least seem wise for a pupil to know how to use a camera.

Simple. There is the greatest variation in the matter of simple or dissecting microscopes. The idea in all is the same, but its presentation varies from quite elaborate dissecting instruments, costing $10 or $12 each, to home-made affairs, which seem to answer every purpose, costing 25 cents to $1 each. In the home-made instruments the price depends upon the lens used. At the Michigan Agricultural College Coddington lenses are used of about $\frac{1}{2}$ inch focal distance. The wire handle is held by a narrow slit in a small post in block of wood about 3 inches long. Such an arrangement will make a good dissecting lens cost about $2.10.

This lens can be removed and used as a pocket lens. Probably the simplest form of dissecting instrument is that described by Professor Barnes in this number. In quite common use are the boxed instruments, in which the box is used as the base of the instrument. The Bausch and Lomb dissecting microscopes are in common use, and they are spoken of here in order to recommend those who contemplate getting them, to order the unjointed, instead of the folding stand, as the latter is always a nuisance to pick up by the stage, and, as Professor Trelease writes, "who doesn't pick them up by the stage?"

ACCESSORY INSTRUMENTS.—*Microtomes.* The most universally used microtomes appear to be razors and scalpels, the relative merits of which will probably never be settled. One who uses a razor can not be induced to use a scalpel, and probably the reverse is also true. But either will do if sharp enough, and upon this point of sharpness there is no dissenting voice. A day or two spent in learning how to sharpen a razor or scalpel is never lost time. Plenty of good oil stones should be kept on the tables, and Professor Bessey suggests the use of a mixture of about equal parts of glycerine and water instead of oil. Regular microtomes seem to be not very commonly used, though most laboratories possess one or more for use when necessary, but all the ordinary sections of the laboratory are made "free-hand." As an imbedding substance the laboratories are about equally divided between the pith of elder and that of the common sunflower. Dr. Rothrock says there is nothing better than the latter, but that it should be cut when the stalk is mature and *slowly* dried. In reference to section-cutting the reader is referred to Professor Burrill's paper on the subject in this number.

Forceps. The ordinary forceps supplied with microscopes are universally condemned as coarse and awkward and inexcusable. "Dental forceps," made of steel or brass, nickel-plated, are generally recommended, and if but one is supplied to each student it had better be curved at the tip. They can be bought by the quantity at from 15 to 40 cents each, depending on whether they are brass or steel.

Dissecting needles and *brushes.* All dissecting needles seem to be home-made. The most explicit direction comes from the Michigan Agricultural College, where number 5 needles are broken about $\frac{2}{5}$ from the head and pushed with forceps, blunt end first, into the pith of a small branch of European larch. Of course any fine needle held firmly in any convenient handle is all that is required. While this does very well for dissecting, some of us are not willing to remove delicate sections with them, and every student should learn from the first to handle all his sections with the greatest care so that it may become second nature. For this purpose the most convenient plan is to fasten a small camel's hair brush to the other end of a dissecting needle. The brush should be one easily drawn to a point. The advantage of having it fastened to a dissecting needle is that when not in use the needle may be kept stuck in the table and the brush thus out of the chance of dust. In this way the most delicate sections can be handled without injury and nice habits of manipulation cultivated.

TABLE ACCESSORIES.—*Reagents, etc.* Here, too, the matter of expense varies widely, some laboratories possessing the elaborate bottles with etched lables and dropping tube attachment that are very complete and very costly. In most cases too many reagent bottles are needed to furnish them all of such grade. Probably the most convenient and economical method is that of those who use ordinary cheap 2 oz. bottles with cork stopper, each stopper having a glass rod or small tube running through it to near the bottom of the bottle. Several object to this arrangement, and prefer to use bottles with ground glass stoppers and small pipettes, such as can be purchased at the drug stores as "eye-droppers," which do not cost more than 5 cents each. The ordinary reagents upon the table are Iodine, Alcohol, Potassic Hydrate, Glycerine, and Water; other reagents, such as acids and staining fluids, not being distributed individually, but supplied as needed. The greatest puzzle seems to be how to treat potassic hydrate so that the bottle may be kept closed and the stopper neither eaten nor stuck fast. Professor Bessey suggests a very simple plan. It is to take a narrow-necked bottle and use for the stopper a pipette with bulb large enough to prevent slipping into the bottle. The bulb will thus drop into the neck and act as a stopper and the pipette be ready for use. Several are troubled with the scum that collects on the potassic hydrate. The best remedy for this is to supply but small amounts of the reagent and when the scum becomes troublesome empty the bottle.

Glass-slips and *cover-glasses* go with the saying and need no word of comment or explanation.

SHELF ACCESSORIES.—*Bell-jars.* For covering specimens and cultures these are indispensable. In many cases tumblers will answer every purpose, but there should be larger bell-jars, and some with ground bottoms.

Glass plates. A number of these should be provided large enough for the bell-jars or tumblers. By this means air-tight cells can be made by oiling the bottom of the bell-jars.

Soup plates are very useful for keeping many specimens in, especially the aquatics in such common use. The glass plates or bell-jars can be used for covering them.

Watch glasses. The ordinary watch glasses are in common use for holding small specimens, and especially for containing the reagents used in treating sections. The ease with which they are overturned is spoken of, and a remedy suggested in securing those with flat bottoms. A still simpler and safer way is to use individual salt-cellars.

Test tubes and *tumblers* are also supplied in all the laboratories.

MOUNTING.—All ordinary mounts are made in water, or in the reagent used. Mounts to be preserved for several days are made in glycerine. Thus far all accounts agree, but when it comes to the question of permanent mounting, there is a great variation in custom.

In some cases permanent mounting would seem to be the object of the course, in others it is not employed at all, or even taught. A wise mean seems to be that which teaches how to make permanent mounts, and thus preserves everything worth preserving, but never mounts for mounting's sake. It is questionable whether in the time devoted to the study in most of our laboratories much attention should be paid to this purely mechanical phase of the work. In reference to permanent mounts Dr. Rothrock makes the following suggestion: "When an object is mounted and designed for preservation, an occasional difficulty is experienced as to some suitable substance which is fairly strong and which will not run under the cover when used as a ring to hold the cover in place. For this probably nothing is better than a rather thick solution of gum shellac in alcohol. This will meet the requirement in most cases, providing the object is so thin as to leave no appreciable space between the glass slip and its cover. When the shellac hardens, as it will quickly, a final ring may then be run over it. This is especially valuable when the object is mounted in any of the balsam preparations."

The facts above given embody most of the information received from our best laboratories, and while professional workers may receive from them but few hints, the many who are desiring to equip laboratories in a way both cheap and efficient, will be helped to what they need, by those who have had much experience in such matters.